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A NEW LATE EOCENE SPECIES OF PLOTOPTERIDAE (AVES: PELECANIFORMES) FROM NORTHWESTERN OREGON

By
James L. Goedert

15207 84th Ave. Ct. NW, Gig Harbor, Washington 98335 and Museum Associate, Section of Vertebrate Paleontology, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007

Abstract: A new genus and species of penguin-like pelecaniform bird, *Phocavis maritimus*, is represented by a single right tarsometatarsus. This fossil is from the deep-water sediments of the Late Eocene age Keasey Formation in northwestern Oregon and is the oldest known member of the extinct family Plotopteridae.

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Introduction

A recently discovered tarsometatarsus from the Late Eocene age Keasey Formation of northwestern Oregon (Fig. 1) represents the oldest known member of the family Plotopteridae and is the first record of a plotopterid from rocks in Oregon. The first species of the family to be recognized was *Plotopterum joaquinensis* Howard, 1969, based on the scapular end of a left coracoid from the Early Miocene age Pyramid Hill Sand Member of the Jewett Sand in Kern County, California. Howard erected a new family, the Plotopteridae, for this penguin-like pelecaniform bird. Unnamed specimens of Late Oligocene and Early Miocene age from Japan, some of which include tarsometatarsi, have been discussed and figured by Hasegawa et al. (1979), and the family was reviewed by Olson and Hasegawa (1979). Another plotopterid, *Tonsala hildegardae* Olson, 1980, was described from a partial skeleton that was collected from the Oligocene and Early Miocene age Pysht Formation in northwestern Washington. The most detailed diagnosis of the Plotopteridae was presented by Olson (1980). An isolated femur from Middle Miocene age rocks in Japan, originally referred, questionably, to the Phalacrocoracidae (Hasegawa et al. 1977) has been assigned to the genus *Plotopterum* by Olson and Hasegawa (1985). Other undescribed plotopterids have been mentioned by Olson (1985) in a recent summary of the fossil record of the Plotopteridae.

The specimen described here cannot be directly compared to *Plotopterum joaquinensis* or *Tonsala hildegardae* until the tarsometatarsi of these species are found. The unnamed specimen from Kyushu, Japan (Hasegawa et al. 1979) includes the only previously described plotopterid tarsometatarsus. Current knowledge of the morphology of the leg in the Plotopteridae is, however, sufficient (Hasegawa et al. 1979; Olson and Hasegawa 1979, 1985; Olson 1980, 1985) to establish the familial allocation of the new genus and species.

Avian skeletal terminology used here follows

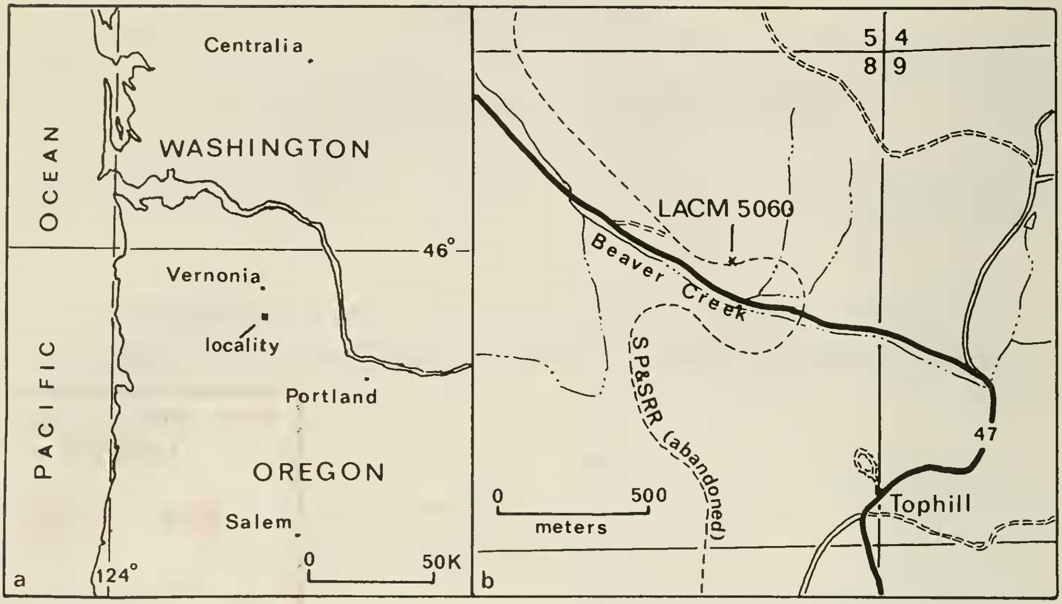

FIGURE 1. Location map. (*a*) Map of southwest Washington and northwest Oregon showing location of *b*; (*b*) type locality, LACM 5060 (Vernonia Quadrangle, 1979 edition).

that of Howard (1929). The repository for the holotype is the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A., and is abbreviated LACM. The specimen described here was found with the distal end protruding from a small, extremely hard concretion, and was initially prepared by etching with dilute acetic acid. The remaining matrix was removed with an air abrasive unit. The specimen is dark brown in color and, to enhance details, it was coated with ammonium chloride before being photographed.

SYSTEMATIC PALEONTOLOGY

Order PELECANIFORMES Sharpe, 1891
Suborder SULAE Sharpe, 1891
Family PLOTOPTERIDAE Howard, 1969

Plotopterinae Brodkorb, 1971:174, as a subfamily of Phalacrocoracidae.

AMENDED DIAGNOSIS OF FAMILY.—The new taxon has an overall tarsometatarsal morphology closely resembling that of an unnamed plotopterid from Kyushu, Japan (Hasegawa et al. 1979). Although the published description of the Kyushu specimen is very brief and the figures are of an unprepared specimen, it appears to share with the new taxon the following combination of characters: tarsometatarsus with a high and rounded intercotylar prominence positioned off-center laterally; internal cotyla large, deeply concave, and open anterodistally; internal calcaneal ridge greatly enlarged and rounded proximally; shaft widened lateromedially and flattened anteroposteriorly; internal trochlea rounded and slightly knoblike anteriorly; middle trochlea longest, directed strongly anteriorly, positioned well off-center medially; external trochlea shortest, directed posteriorly; and large, deep metatarsal facet.

TYPE GENUS.—*Plotopterum* Howard, 1969.

INCLUDED GENERA.—*Plotopterum* Howard, 1969; *Tonsala* Olson, 1980; *Phocavis* new genus; unnamed genera from Japan.

Phocavis new genus

DIAGNOSIS OF GENUS.—Tarsometatarsus stout with slender and extremely anteroposteriorly flattened shaft; high and anterodistally overhanging intercotylar prominence; large, concave internal cotyla nearly twice as large as external cotyla; deep, medially placed metatarsal facet; middle trochlea longest, anteriorly directed, and off-center medially; external trochlea large and posteriorly directed; and internal trochlea large, posteriorly directed, and rounded anteriorly.

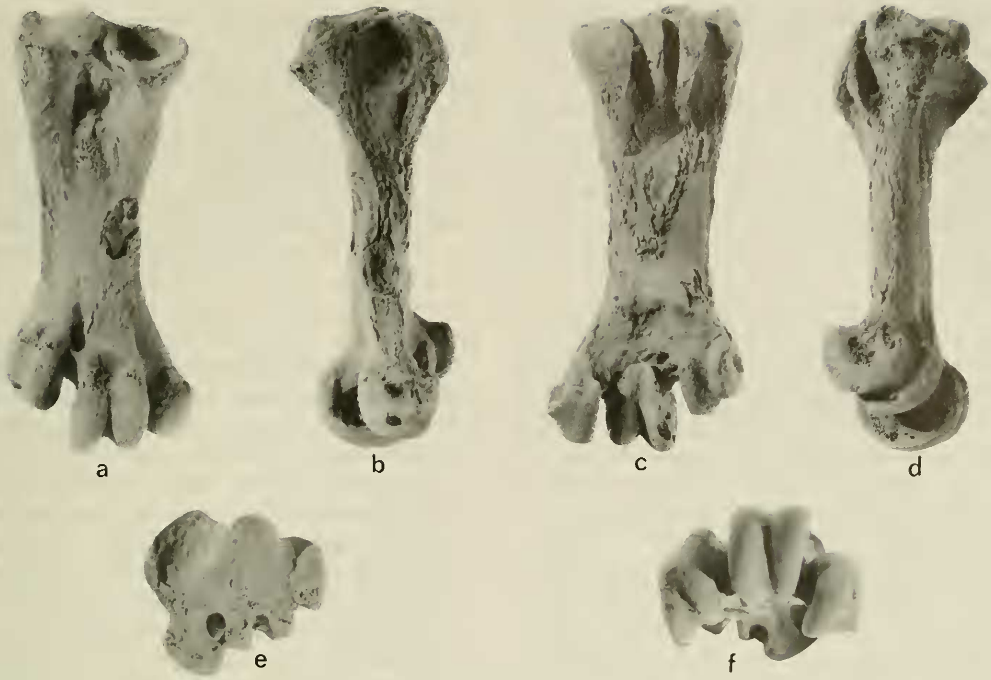

FIGURE 2. *Phocavis maritimus* new genus and species, holotype, right tarsometatarsus, LACM 123897, natural size. (*a*) Anterior; (*b*) medial; (*c*) posterior; (*d*) lateral; (*e*) proximal; (*f*) distal view.

ETYMOLOGY.—From Latin; *Phoca,* seal (the mammal), and *avis,* bird, in reference to the probable swimming habitus of the taxon.

TYPE SPECIES.—*Phocavis maritimus* new species.

Phocavis maritimus new species
(Figure 2)

DIAGNOSIS OF SPECIES.—As for the genus *Phocavis.*

ETYMOLOGY.—Latin; *maritimus,* seafaring, of the sea.

HOLOTYPE.—LACM 123897, right tarsometatarsus, lacking end of wing of internal trochlea, collected by the author, 28 October 1979.

TYPE LOCALITY.—LACM 5060. Rocks exposed along the north side of an abandoned railway roadbed at the west end of a cut near the center of the SE¼, SW¼, NE¼ of Section 8, T. 3N., R. 4W., Vernonia 7.5 minute quadrangle (1979 edition), Washington County, Oregon.

FORMATION AND AGE.—Upper part of the middle member of the Keasey Formation, Late Eocene. The Keasey Formation is exposed throughout the upper Nehalem River basin in northwestern Oregon and consists of approximately 700 m of tuffaceous siltstones and massive mudstones with locally abundant concretions. It has been subdivided into lower, middle, and upper members (Warren et al. 1945; Warren and Norbisrath 1946; Moore and Vokes 1953). The molluscan fauna from the Keasey Formation indicates a Late Eocene age (Hickman 1976, 1980, written comm. 1982) and deposition at depths of between 500 and 1,000 m (bathyal), although rare specimens of shallow water origin (apparently transported) have been found (Moore and Vokes 1953; Lindberg and Hickman 1986). The Keasey Formation is correlative with the *Echinophoria dalli* Molluscan Zone, Galvinian Molluscan Stage, Refugian Foraminiferal Stage, Priabonian Global Chronostratigraphic Stage, and the upper part of the Duchesnean Land Mammal Age of North America (Armentrout et al. 1983).

Other vertebrate fossils known from the Keasey Formation include a large bird, probably a pseudodontorn (currently under study), shark teeth (Welton 1972, 1973), teleost otoliths and bones, a marine turtle (University of California, Museum of Paleontology, Berkeley), and cetacean vertebrae (Northwest Museum of Natural History, Portland State University, David Taylor, pers. comm.).

MEASUREMENTS (IN MM).—Length 59.6, width of proximal head 23.6, width of shaft at level of metatarsal facet 13.9, width of distal end through trochleae 25.7, width of middle trochlea 10.1.

DESCRIPTION.—The tarsometatarsus of *P. maritimus* differs from that of the unnamed plotopterid from Kyushu, Japan (Hasegawa et al. 1979) in being much smaller and more elongate (relative to proximal and distal width), and by having a hooklike and anterodistally overhanging intercotylar prominence; external cotyla more open anterodistally; hypotarsus with internal tendinal canal partially closed proximally; distal foramen separate from intertrochlear notch; internal trochlea extending farther distally; and external trochlea tilted more laterally.

Two measurements for the Kyushu tarsometatarsus are given by Hasegawa et al. (1979: 45): overall length (103.9 mm) and proximal (?) width (50.6 mm). The Kyushu specimen represents an animal approximately twice as large as *P. maritimus. Phocavis maritimus* was a much larger animal than *Plotopterum joaquinensis,* but may have been slightly smaller than *Tonsala hildegardae.* Newly discovered specimens of *T. hildegardae* from Washington are in preparation and under study and indicate that the tarsometatarsus, when found, may be more like that in *Anhinga* spp. than that of *P. maritimus.*

DISCUSSION

If the plotopterid specimens from Japan were not known, *Phocavis maritimus* would have been assigned to the Pelecaniformes, but could not have been assigned to any known family. There are, however, some superficial similarities between the tarsometatarsus of *P. maritimus* and living species in the pelecaniform family Anhingidae. The similarities between bones of the hindlimbs of the Plotopteridae and Anhingidae have been discussed by Olson and Hasegawa (1979, 1985) and Olson (1980, 1985), and further suggest the assignment of *P. maritimus* to the Plotopteridae.

Geologically, *P. maritimus* is much older than the described plotopterids from Japan and *Plotopterum joaquinensis* from California. Olson (1980) assigned an age of Late Oligocene to *Tonsala hildegardae.* The type locality for *T. hildegardae* is within Durham's (1944) *Echinophoria rex* (now *Liracassis rex*) molluscan zone, recently assigned an age of Early Oligocene (Moore 1984). A mollusk collection from rocks near the type locality for *T. hildegardae* (perhaps Durham's locality A3690), USGS M8986, contains *Liracassis apta* (Tegland 1931) and is Early Miocene in age (E. J. Moore, written comm. 1986). Durham (1944:110) assigned an age of Middle Oligocene to that part of his *Echinophoria* (*Liracassis*) *rex* molluscan zone. I think that *T. hildegardae* is older than Late Oligocene, but more work on the geology and biostratigraphy of the Pysht Formation must be done before *T. hildegardae* can be given a precise age assignment (see Domning et al. 1986:6–12).

It has been suggested that extinction of the Plotopteridae and, in the southern hemisphere, the giant penguins, was a result of the rise of seals and porpoises (Olson and Hasegawa 1979; Olson 1980, 1985), which presumably resulted in competition for the same food resources. Evidence now available, however, suggests that plotopterids and a previously unknown diversity of cetaceans, including small odontocetes, contemporaneously occupied the eastern North Pacific Ocean from at least as early as Late Eocene time until the apparent extinction of the Plotopteridae in Middle Miocene time. Cetacean vertebrae have been collected from the Keasey Formation and they are also known from Late Eocene and/or Early Oligocene age rocks on Vancouver Island (Kellogg 1936; Barnes 1977). Also, a variety of small, toothed cetaceans are known from Late Eocene and Oligocene age sediments of Washington (undescribed specimens, collections of U.S. National Museum, collections of LACM, and field observations). *Tonsala hildegardae* was found in the same rocks as a very diverse cetacean assemblage (Domning et al. 1986), which includes many different species of small archaic odontocetes.

A major change in marine endotherm faunas (Lipps and Mitchell 1976) occurs in latest Oligocene time with the appearance of the enaliarctine pinnipeds (Repenning and Tedford 1977; Barnes 1979). The rapid diversification and dispersal of these pinnipeds in the North Pacific Ocean in Late Oligocene and Early Miocene time may, in fact, be linked to the extinction of the Plotopteridae, but the extinction of the plotopterids and the nearly simultaneous appearance of the pinnipeds is more probably related to climatic events. Climate changes and the resultant oceanographic changes which affect phytoplankton diversity can have enormous impact on marine vertebrate populations (Lipps and Mitchell 1976). Therefore, the global warming event that culminated at about 16.4 mya (Early Middle Miocene) and affected plankton and molluscan distributions may be a more probable cause for the extinction of the Plotopteridae (Orr and Faulhaber 1975; Barnes 1977).

Conclusions

A new genus and species of Late Eocene age bird, *Phocavis maritimus,* known only by a single tarsometatarsus, is the earliest known member of the Plotopteridae, an extinct family of the order Pelecaniformes. This is the third species of Plotopteridae known for North America and the first record of the family from Oregon. *Phocavis maritimus* was found in rocks of the upper part of the middle member of the Keasey Formation in northwestern Oregon, and was associated with a molluscan fauna that indicates a Late Eocene age and deposition at a depth of between 500 and 1,000 m. Therefore, unless the specimen is allochthonous, it may be inferred that the animal could move far off shore.

Because the only other described plotopterid tarsometatarsus is that from the partial skeleton of an unnamed taxon from Kyushu, Japan, *P. maritimus* cannot, at present, be directly compared to *Plotopterum joaquinensis* or *Tonsala hildegardae.* Differences in probable body size and geological age are, however, sufficient to further indicate that the Oregon fossil represents a new taxon.

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CALIFORNIA ACADEMY OF SCIENCES
Golden Gate Park
San Francisco, California 94118